BTEC Assignment Brief

Qualification	Pearson BTEC International Level 3 Foundation Diploma in Applied Science Pearson BTEC International Level 3 Diploma in Applied Science Pearson BTEC International Level 3 Diploma in Biomedical Science Pearson BTEC International Level 3 Diploma in Environmental Science Pearson BTEC International Level 3 Extended Diploma in Applied Science Pearson BTEC International Level 3 Extended Diploma in Biomedical Science Pearson BTEC International Level 3 Extended Diploma in Environmental Science
Unit number and title	**Unit 20: Applications of Physical Chemistry**
Learning aim(s)	**B:** Investigate rate equations and activation energy to understand the chemical kinetics of reactions
Assignment title	**Chemical kinetics**
Assessor	
Issue date	
Hand in deadline	

Vocational Scenario or Context	You are a newly appointed chemical engineering technician working for a chemical company that specializes in making a range of chemical products. In your role you to have a good understanding of chemical kinetics. When planning to carry out a new chemical reaction in the laboratory or on a manufacturing plant it is essential to research and gain knowledge about the type of reaction to be carried out. This includes understanding the chemical kinetics of the type of reaction and therefore the effect of on the rate of the reaction by using catalysts, different concentrations and surface areas of reactants and the different temperatures at which the reaction is carried out. This understanding will support you to plan/design the equipment/apparatus or chemical plant, the materials used and estimate the reaction conditions which need to be used to carry out the reaction safely. In your first month in your job your supervisor has set up an induction programme for you. You will need to successfully complete this induction to be able to continue as an employee of the company.

Task	As part of your induction into your new role of chemical engineering technician you are required to investigate the effect of temperature, catalysis and concentration of reactants on the rate of reactions. Your supervisor has also asked you to analyse the rate equation foe at least 5 reactions, carry out calculations to determine the activation energy for at least 5 reactions and demonstrate accurate detrminations of rate equations for at least 5 problems. Your final portfolio will contain the following 5 sections: <u>Section 1 - Investigate the effect of concentration on the rate of a reaction</u> • **Investigate** the rate of reaction by carrying out at least two

	experiments to examine the effect of concentration. Vary the concentration of one reactant whilst keeping the concentration of the other reactant constant and time the experiment. Repeat the experiment by varying the concentration of the second reactant whilst keeping the first reactant constant and time the experiment. For one of the experiments collect continuous data at regular time intervals as well as timed clock reaction methods. For the continuous data experiment plot concentration-time graphs, calculate the gradients of the slopes of tangents of curves and determine the exact relationship between the rate of reaction and the concentration of the reactant. With timed clock reactions plot 1/time vs concentration or $(\text{concentration})^2$ to determine the exact relationship between the rate and the concentration of the reactant. n.b. Possible reactions are: propanone and iodine (in presence of acid), bromide with bromate(V) ions (in presence of acid), persulfate (VI) with iodide ions, sodium thiosulfate and hydrochloric acid, acid and carbonate, or crystal violet with sodium hydroxide <u>Section 2 - Investigate the effect of temperature and catalysis on the rate of a reaction</u> • **Investigate** to examine the effect of temperature and catalysts. Carry out one experiment where the activation energy is determined by varying the temperature and the reaction time is measured using a clock reaction method. Plot ln(1/time) vs 1/T (K^{-1}). Calculate the gradient and use it to determine the activation energy of the reaction (Ea = gradient x 8.31 JK^{-1} mol^{-1}). Carry out a second experiment to investigate the quantitative effect of the catalyst on the rate of reaction. Use the data to draw a graph of ln(1/time) vs 1/T (K^{-1}), calculate the activation energy. Alternatively carry out a second experiment of an uncatalysed reaction monitored using a colorimeter to give a concentration-time graph and repeat with a catalyst. Tangents at T=0 can be taken for both graphs to determine the rate of reaction. Compare the values taken with literature values or values from your fellow learners/the assessor. Note the differences in results and suggest reasons for the differences n.b. possible reactions are: o effect of temperature – sodium thiosulfate and hydrochloric acid, or persulfate (VI) with iodide o effect of a catalyst: – heterogeneous–effect of different potential catalysts on the decomposition of hydrogen peroxide, potassium manganate (VII) with ethanedioate ions – homogeneous–traffic light reaction: effect of cobalt

(II)chlorideontherate on the reaction between potassium sodium 2,3-dihydroxybutanedioate and hydrogen peroxide.

Section 3 - Activation Energy Calculations Worksheet A

- Under supervision in lesson complete 'Activation Energy Calculations Worksheet A'. This worksheet will enable you to:
  - **Carry out** calculations to determine the activation energy for at least five reactions when given the rate constant and temperature data. At least one problem should involve the determination of value of the Arrhenius constant when given all other variables, the rate constant given the temperature and activation energy and the temperature given the rate constant and activation energy.

Section 4 – Reaction Order Worksheet B

- Under supervision in lesson complete 'Reaction Order Worksheet B'. This worksheet will enable you to:
  - **Demonstrate** accurate determinations of rate equations for at least five problems using either tabulated or graphical data. Inspect tabulated initial rate data and deduce orders of reaction. Inspect concentration-time or rate-concentration graphs for characteristics to indicate their order in terms of first, second or zero order. Clearly and logically explain your deductions and write the overall rate equation for the reactions. Use the data to determine their rate constants and units. Calculate the rate of reaction using the rate equation when a number of changes to the concentrations of all three reactants are made. At least one problem will give you the opportunity to determine the value for the Arrhenius constant (A) given all other variables; the rate constant given temperature and the activation energy; the temperature given rate constant and activation energy.

Section 5 Analysis of rate equations

- **Analyse** the rate equation for at least five reactions. Propose and justify the mechanism for each reaction. Alternative mechanisms also need to be provided and you need to justify why these are not correct for the rate equation. Assess the impact of activation energy on the rate of reaction for at least three reactions. Examine the mechanism of each reaction and suggest how the activation energy is used within each. At least one reaction must be catalysed, the mechanism must be shown with and without the use of the catalyst. Also suggest how the catalyst has reduced the activation energy requirement for the reaction.

Checklist of evidence required	A research portfolio that includes: • An investigation to examine the effect of concentration on the rate of reaction • An investigation to examine the effect of temperature and catalysis on the rate of reaction • Calculations Worksheet A • Reaction Order Worksheet B • An analysis showing how the rate equation and activation energies inform the chemical kinetics of reactions

Criteria covered by this task:	
Unit/Criteria reference	To achieve the criteria, you must show that you are able to:
B.D2	Analyse how the rate equation and activation energy inform the kinetics of chemical reactions.
B.M4	Carry out calculations to accurately determine the activation energy of a reaction from data on the rate constant at different temperatures.
B.M3	Demonstrate accurate determination of reaction order, overall reaction equation, rate constant and its units from data.
B.P5	Investigate the effect of temperature and catalysis on the rate of reaction.
B.P4	Investigate the effect of concentration of different reactants on the rate of reaction, determining accurate values from concentration-time plots.
Sources of information to support you with this Assignment	All sources of information suggested are UK based. Centres are free to amend these sources to those available in the Country of delivery where more appropriate. www.edu.rsc.org.uk – Kinetics starters 1 and 2 (16-18); The effect of concentration and temperature on Reaction Rate; Iodine clock demonstration www.STEM.org.uk - Chemical kinetics; Iodine clock reaction Within the copyright laws learners could search YouTube for: – Chemical kinetics – rate laws; Rates of reactions
Other assessment	Centres must create and internally verify their own versions of the following worksheets referred to in the Task.:

materials attached to this Assignment Brief	1) 'Activation Energy Calculations Worksheet A' 2) 'Reaction Order Worksheet B'
Notes to the Assessor and technician	The practical activities suggested for this assignment are required to be safety checked by the Centre before use. Pearson Education can take no responsibility for the safety of any practical activities. Before doing any practical activity, you should always carry out your own risk assessment and refer to the necessary regulations. In particular, any local rules issued by your employer must be obeyed, regardless of what is suggested here. Centre should use Health and Safety information provided by a reputable source. In the UK such an example organization is CLEAPSS http://science.cleapss.org.uk/